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Indian Standard
SPECIFICATION FOR
REFRACTOMETER — ABBE TYPE

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Indian Standard

SPECIFICATION FOR REFRACTOMETER — ABBE TYPE

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 9 December 1975, after the draft finalized by the Optical and Mathematical Instruments Sectional Committee had been approved by the Mechanical Engineering Division Council.

0.2 Refractometer is an optical instrument used for the determination of refractive index of solids and liquids.

0.3 Since the refractive index of a substance for a certain wavelength at a certain temperature is constant, the purity of substance or concentration of solution can be determined by measurement of refractive index.

0.4 Abbe refractometer is based on the principle of measurement of critical angle. It consists essentially of a pair of prisms (one being a measuring prism and the second for illumination) and a simple inverting telescope in front of which is placed a pair of counter-rotating amici prisms. The two prisms are usually of 30°-60°-90° construction, made from glass, the refractive index of which is higher than the upper limit of the instrument range. The two prisms are housed, one in each half of a hinged water jacket. The telescope is arranged to rotate around an axis passing through the prism housing. The latter is rigidly attached to a sector arm, on the arc of which is engraved a calibrated refractive index scale. A reading microscope is conveniently positioned to help reading the index scale.

It is used for general refractometric measurements of a wide variety of liquids or transparent solids, in scientific analysis and industrial process control where refractive index varies from 1.30 to 1.70.

1. SCOPE

1.1 This standard covers the general and functional requirements of Abbe refractometer.

2. TERMINOLOGY

2.0 For the purpose of this standard, the definitions given in IS : 1399-1959* and the following definitions shall apply.

*Glossary of terms used in optical technology.

2.1 Dividing Line — The line separating the two fields into bright and dark parts, as seen in the field of view of the ocular. This separation line is the border line of total reflection.

2.2 Illuminating Prism — Light falling upon the mirror is reflected in the lower prism of the refractometer which is called the illuminating prism.

2.3 Refracting Prism — Light from the illuminating prism passes through the thin layer of the liquid to be examined and enters the upper prism called the refracting prism of the refractometer. From here it passes into the telescope.

2.4 Amici Prism — Amici prism is a combination of three prisms whose refractive indices and angles are so chosen that it permits helium d-line to pass without changing its direction, but when light of other wavelength passes, it changes direction and causes dispersion.

2.5 Mean Dispersion — It is the difference between the refractive indices of the material for C and F lines of hydrogen.

2.6 Dry Substance Scale — It corresponds to the 'International Scale 1936*' and thus directly indicates in the case of pure sugar solutions, the sugar percentage.

2.7 Compensator — It comprises two amici prisms. By rotating the two prisms in opposition, it is possible to attain any required degree of dispersion to make the dividing line achromatic.

3. GENERAL REQUIREMENTS

3.1 Abbe refractometer shall conform to the general requirements as laid down in IS : 988-1959†, IS : 1400-1960‡ and IS : 2754-1964§ regarding the materials used in its construction.

3.2 For liquids, it shall cover refractive index scale from 1.30 to 1.70 and for solids, scale reading from 0 to 85 percent.

3.3 Accuracy for liquids shall be assured to ± 1 in the fourth decimal place and for solids directly to 0.2 percent and estimated to 0.1 percent.

3.4 Glass test pieces certified by National Physical Laboratory and marked with refractive index shall be used to check the accuracy of the refractometer. If the instrument is off, the direction of the beam inside the instrument can be adjusted with the help of Allen wrench through an

*Recommended by the International Commission for Uniform Methods of Sugar Analysis (ICUMSA).

†General requirements for optical components.

‡Specification for optical glass.

§General requirements for optical instruments.

opening in the side of the instrument. Alternatively, a series of pure hydrocarbons with refractive indices certified by National Physical Laboratory to the fourth place of decimal, shall be provided.

3.5 Base — The base shall be of heavy construction for stability.

3.6 Housing — The refractometer housing shall be of suitable construction and stable. It shall be streamlined for appearance and so designed as to cover the scale and all internal moving parts and protect them from damage due to dust, fumes and stray liquids. The instrument body shall have low centre of gravity so as to make it difficult to topple over.

3.7 Prism Set

3.7.1 The refracting and illuminating prisms shall be firmly held in a water-jacketed mount of stainless steel or any other suitable material with adhesive impervious to attack by food acids and organic compounds.

3.7.2 An arrangement for maintaining precise temperature control by running water in the water jacket shall be provided.

3.7.3 The water jacket shall be able to take a thermometer for taking reading at different temperatures.

3.7.4 The thermometer shall be graduated from 0°C to 100°C .

3.7.5 The two prisms of the refractometer shall be of equal dimensions and sufficiently large in size for greater accuracy and better illumination of the sample. Both the prisms shall be of same refractive index. The refractive index shall be more than 1.70.

3.7.6 The hypotenuse face of the illuminating prism shall remain mat and unpolished; where as the hypotenuse face and the face between 60° and 90° of the refracting prism shall be optically polished.

3.7.7 The hinged prism which is not used for determination of refractive index of transparent solids, shall be completely removable from the instrument body.

3.7.8 The prism set shall be replaceable.

3.7.9 The prism set shall be located centrally with respect to the telescope axis.

3.7.10 Where repetitive measurements of refractive index are required on a series of similar samples, a special attachment (like a flow cell incorporating a water jacketed chamber with funnel and antisiphon drain tube) attachable to the fixed prism surface, in place of hinged prism, may be made available.

3.7.11 The two prism castings shall be secured together by strong hinges and brought together into correct parallelism and locked in position by a suitable latch. The latch knob shall be insulated.

3.7.12 The refractometer prism shall be illuminated by day light or other exterior source, reflected by a mirror or by artificial light from the built-in illuminator.

3.7.13 The movement of the refractometer prism set shall be relative to the telescope, the prism set being rigidly fixed to the scale.

3.7.14 The prism box shall be strong and corrosion resistant.

3.8 Telescope System

3.8.1 The refractometer shall have a telescope for setting the dividing line. The telescope shall have Ramsden type eyepiece, scale, objective and a set of counter-rotating amici prisms placed in front of the telescope.

3.8.2 The telescope shall be of simple inverting type.

3.8.3 Focussing arrangement for the eyepiece of the telescope shall be provided.

3.8.4 The telescope eye piece tube shall be properly inclined so as to avoid fatigue during prolonged usage.

3.8.5 The ocular shall be adjustable for focussing and fitted with a cross web.

3.8.6 The internal side of the telescope tube shall be blackened dull to avoid stray lights.

3.9 'Amici Prisms

3.9.1 The telescope of the refractometer shall be fitted with two amici prisms, rotatable in opposite directions and having exactly equal dispersion.

3.9.2 The two prisms shall be so designed that only helium d-line passes through it without deflection, while the other rays disperse in relation to their own wavelengths.

3.9.3 The amici prism unit shall be fitted with the direct reading scale to be employed with white light to find the C-F dispersion of the sample.

3.10 Scale

3.10.1 The refractometer shall be provided with a glass or metal circular scale graduated directly for refractive index and also if required for a sugar percentage scale. The metallic scale, if provided, shall be calibrated at 20°C. The scale shall be completely enclosed dustproof.

3.10.2 The scale shall carry two distinct columns of graduations, one with direct refractive index values from 1.30 to 1.70 and the other for dry substance values from 0 to 85 percent.

3.10.3 The refractive index scale shall accurately read to the third decimal place directly and to the fourth decimal place by estimation, without the use of tables or calculations.

3.10.4 The sugar scale or dry-substance scale shall directly read accurately to 0.2 percent and by estimation to 0.1 percent.

3.10.5 The graduated circle shall be transilluminated either by daylight or by an internally built-in light source.

3.10.6 The lamp shall be equipped with a diffused illumination arrangement, adjustable for either transmitted or reflected light.

3.10.7 A reading magnifier shall be provided on the body of the instrument for reading the circular scale. The magnification should be such that two close divisions are clearly visible. The field of view should be such that at least two numbered divisions are visible. Magnifier should have arrangements for vertical illumination of the scale.

3.10.8 The magnifier for reading the scale and the telescope for observing the border line of total reflection shall be firmly connected and have an oblique direction of view convenient for observation.

3.10.9 The two oculars of the telescope and magnifier shall be side by side for convenience of reading.

3.10.10 Micrometer for fine adjustment shall be provided whenever necessary for accurate setting.

3.11 Operating Mechanism

3.11.1 The working parts of the refractometer shall be designed to compensate for wear and tear and machined to fine tolerances necessary to maintain the high order of accuracy inherent in optical systems.

3.11.2 The actuating knobs and wheels shall be of large size for easy grip and shall be located in low position for operating comfort.

4. FUNCTIONAL REQUIREMENTS

4.1 The movement of the scale and other moving knobs shall be smooth and free from any backlash.

4.2 The field of view in the ocular of the telescope, divided into light and dark parts, shall be well-defined and clearly visible with good contrast.

4.3 The telescope shall be rigidly attached to the prism housing without any free movement and give accurate index reading and dispersion factors. The telescope axis should be perpendicular to the axis of rotation of the refracting prism.

4.4 Focussing arrangement of the telescope if provided, shall not shift the reflected beam and the optical axis of the telescope, when the telescope is adjusted.

4.5 The dispersion shall vary with rotation of the amici prisms and the rotation shall be smooth.

4.6 The amici prisms shall eliminate colour fringes to give a sharp and distinct dividing line.

4.7 The magnifier for reading graduations shall read with clearness and good contrast.

4.8 The ocular of the magnifier shall be adjustable in sleeve.

4.9 The thermometer shall be adjustable for easy reading regardless of prism rotation.

4.10 A snap action fastener shall be used to close the two prisms together for liquid samples and the liquid shall not drain off in any position of the prism set.

5. TEST

5.1 The centering of the prism set with respect to the telescope axis shall be checked.

5.2 The water jackets of the prisms set shall be checked and tested at a pressure of 0.14 M Pa.

5.3 Sugar scale calibration shall conform to the recommendations of the International Commission for Uniform Methods of Sugar Analysis (ICUMSA) (1936).

5.4 The telescope and the reading magnifier shall be checked for conformity to IS : 2754-1964*.

5.5 The optics shall be checked for conformity to the requirements laid down in IS : 988-1959†.

5.6 Performance Test — With a test sample of known refractive index placed in position, the telescope shall be rotated to pick up the critical angle boundary which in white light will appear coloured. The amici prisms shall be rotated in order that they may impose a dispersion equal and opposite

*General requirements for optical instruments.

†General requirements for optical components.

to the dispersion of the measuring prism plus the sample system. When this condition is reached and the boundary has become almost achromatic, it shall then be set accurately on the telescope graticule. The rotational passage of the telescope relative to the sector scale shall then give the refractive index of the test sample. By using various test samples of different refractive indices the calibrated scale shall be tested at three or four places.

6. ACCESSORIES

6.1 The following accessories shall be supplied with the refractometer:

- a) 1) High refractive index liquid,
 - 2) Monobromo-naphthalene (for refractive index of 1.64 and under) — 300 g,
 - 3) Methyl di-iodide (for refractive index 1.64 and above) — 300 g;
- b) Small optical glass plate — one;
- c) Brush — one;
- d) Linen/chamois skin;
- e) Thermometer; and
- f) Spare bulbs — two (in case the instruments is provided with a built-in illuminator).

7. MARKING

7.1 Each refractometer shall be marked at a suitable place with the manufacturer's name or trade-mark and the serial number. If required by the purchaser, the refractometer, may also be marked with the year of manufacture.

7.2 The marking of the objective and eyepiece shall be according to IS : 3081-1965*.

7.2.1 The refractometer may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

*Dimensions and marking of general purposes microscopes.

8. PACKING AND PACKAGING

8.1 The refractometer shall be delivered in a thoroughly clean and dry condition, free from all traces of foreign material.

8.2 The mirror, if provided, shall be wrapped in a clean, dry and acid-free tissue paper, which shall be retained in position during transit.

8.3 The oculars and the prism set shall remain in position and wrapped in a dry, clean and acid-free tissue paper.

8.4 The objective and the amici prism set, if projecting out of the housing shall be wrapped in a position as mentioned in 8.3.

8.5 The refractometer shall then be suitably placed inside the box and held in position by suitable arrangement.

8.6 A bag of dry silica gel with indicator adequate for the internal volume of the case shall be suitably placed inside the case carrying the refractometer.

8.7 The empty space, if any, in the case shall be filled with suitable packing material.

8.8 The wooden box along with its contents, shall be locked during transit and the keys attached to the handle.

8.9 The package shall be marked with the description and the number of contents, the standard symbol for indicating contents [*see* IS:1260 (Part II)-1973*], the legened 'HANDLE WITH CARE', in red and the symbol for 'RIGHT-WAY UP'.

8.10 Instructional booklet for the use of the instrument shall be supplied with each instrument.

*Pictorial markings for handling and labelling of goods: Part II General goods (first revision).

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- 988-1959 General requirements for optical components
- 1399-1959 Glossary of terms used in optical technology
- 1400-1960 Optical glass
- 2754-1964 General requirements for optical instruments
- 3099-1965 Slides and cover slips for microscopes
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